

## **Earth Science Data Systems Software Reuse Working Group 2009 Year-end Report**

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### **2009 Accomplishments**

The Software Reuse Working Group (WG) focuses on addressing the issues required to enable and facilitate the reuse of software assets within the NASA Earth science community by undertaking a variety of activities in the areas of implementation, support and enablement, education and public outreach, policy change, and reuse incentives. The main goals of these activities are to help software developers and NASA spend less time, money, and effort on software development, increase productivity and improve quality through reuse, and increase the number of available reusable assets. Activities during 2009 that contributed to these goals included:

1. Recommendations to NASA Headquarters to encourage and enable software reuse;
2. Completion of an initial prototype (for internal NASA use) of the proposed reuse enablement system (RES);
3. Development of a test plan and a policy document for the proposed RES, continued development and maintenance of a Web-based portal;
4. Continued running of a peer-recognition award process;
5. Continued refinement of reuse readiness levels;
6. Continued publications and presentations on software reuse in the Earth science domain; and
7. Engaged the Innovative Partnerships Program (IPP) Office in discussions on reuse topics.

These efforts are related to one another, and their success has been due in part to our interactions with other working groups through joint meetings. Throughout the year, we have held monthly full working group telecons and weekly support team telecons.

Recommendations to and Responses from Headquarters: We recommended that NASA develop standard language for use in future procurement and grant notices that will encourage more software reuse, much like Applied Sciences solicitations added Benchmarking and verification and validation (V&V) requirements in 2004, establish a Web-based information portal for the

sharing and dissemination of information about software reuse practices for the Earth science community, establish an RES to facilitate cataloging and distribution of reusable assets for the Earth science community, and recognize and officially support a Peer-Recognition Software Reuse Award operated by the Reuse WG.

Headquarters has responded positively to our suggestions and is developing language to implement them, e.g., in the Research Opportunities in Space and Earth Sciences (ROSES) announcements. Headquarters encourages continued development of the Software Reuse Web site (<http://www.esdswg.com/softwarereuse>). The WG is in the process of completing RES documentation and seeking a decision from Headquarters on direction of future work in this area. Headquarters also supports the WG's Peer-Recognition Software Reuse Award.

RES Prototype: Based on the results of our architecture study, we developed a build plan for creating a prototype RES for internal NASA use, using the XOOPS content management system software as the foundation of the system. The gap analysis performed in the architecture study indicated what modifications were needed in order to meet all of our requirements. These modifications were then ordered and grouped into three builds and one release. We have completed the modifications for Release 1 and have been making minor modifications to improve the user interface and the system's responses to users attempting to perform actions that they do not have permission to perform. We are also in the process of completing a test plan, which can be used to test the prototype RES and ensure that it meets all of the previously defined requirements, and a policies document, which outlines policies for the operation and maintenance of the proposed RES. The test plan document and an RES policies document are being discussed in the full working group and on track for a February 2010 initial publish date.

The WG has also discussed the relation of the proposed RES to the NASA data centers and existing similar software catalogs and repositories. Recognizing the importance of keeping software with the relevant data, we think that NASA data centers, as well as the existing Tier 1 NASA decadal survey missions (SMAP, CLARREO, ICESAT II, and DESDynI), may be a suitable option for hosting one or more reuse enablement systems. In the case of multiple, distributed systems (e.g., one per data center/mission, focused on each center's area of expertise), linkages between them would be necessary to provide federated searching of and access to software in these multiple systems. One central catalog system could serve this purpose. We plan to pursue this topic further in the coming year.

Guideline Documents: The WG began collecting information to produce a number of guidelines and best practices on topics in software reuse. To date, effort has been focused on collecting details about the software release process at various organizations in order to determine commonalities between them and help provide software developers with general guidance on releasing software for reuse. We have also reestablished our connections with the IPP Office to update our guidelines on the NASA software release process. We also seek to provide input on the NASA process and suggest methods for improving it. Other topics being examined for guideline documents include the use and application of new technologies such as service-oriented architecture (SOA), web services, cloud computing, and grid computing to software reuse, and best practice recommendations for packaging reusable assets for release and distribution.

Portal Web Site: We designed, developed, and now maintain a Web site (<http://www.esdswg.com/softwarereuse>) for providing news and information on reusable assets, links to various catalogs (e.g., Global Change Master Directory, Ames and GSFC Open Source), links to funding opportunities, and dates and contact information for upcoming events relevant to software reuse. Statistics have shown increases in the number of unique, new, and repeat visitors, as well as an increase in the number of visits over the past year. This year, September 2009 had the highest number of unique visitors (2,223) and visits (2,481), which is approximately twice that of last year's peak month (December 2008). This doubling is representative of the year as a whole, with 16,294 unique visitors making 20,123 visits in 2009 compared with 8,353 unique visitors making 10,894 visits in 2008. Since the percentage of repeat visitors is comparable in both years, the large increase in the number of visitors indicates that the site is continually receiving new, first-time visitors. The largest number of page views (4,002) occurred in October 2009, which is up somewhat from last year's peak of 3,835 page views in October 2008.

The WG has a procedure for reviewing nominated selected references for articles to be cited on the portal Web site as external resources relevant to software reuse. At least three independent reviews of each nominated article are required, with the consensus opinion deciding if the article is added to the portal Web site. No articles were reviewed in 2009, but previously nominated references that had not been reviewed were added to their own folder on the portal Web site. This provides visitors with additional potentially useful references while separating the nominated items from the reviewed items. We also have begun identifying articles and other publications that cite WG resources.

Other Resources: We also developed and now maintain a collaboration Web site and a WG mailing list, and prototyped a mailing list for announcements related to the RES.

Collaboration Web Site: <http://www.sciencedatasystems.org/reuse/default.aspx>

Mailing List: [http://majordomo.gsfc.nasa.gov/cgi-bin/majordomo/info/software\\_reuse](http://majordomo.gsfc.nasa.gov/cgi-bin/majordomo/info/software_reuse) (Web site is Goddard-only access)

RES List: <http://softwarereuse.net/lists/> (prototype – one possible solution for RES list)

Peer-Recognition Award: As part of our work to encourage reuse, we executed our process for a Peer-Recognition Software Reuse Award run by the WG as one of our incentive activities. The award is intended to recognize those people whose efforts and projects contribute to the practice of software reuse in the Earth science community. The award consists of a certificate of recognition, an article of recognition featured on the WG portal Web site (<http://www.esdswg.com/softwarereuse>), announcement of award receipt at the annual ESDSWG Meeting, and acknowledgement of award receipt in the Software Reuse WG annual report. In 2009, there were three award recipients:

- Contribution Award Category: 1 recipient
    - **SeaDAS Development Team**, NASA GSFC
      - *SeaWiFS Data Analysis System (SeaDAS)*  
(<http://oceancolor.gsfc.nasa.gov/seadas/>)
- Recipients (alphabetically): Gene Feldman, Bryan Franz, Joel Gales, Michael MacDonald, Fred Patt, Xiao-Long Wang

- Utilization Award Category: 1 recipient
  - **NPP Science Data Segment Team**, NASA and partners
    - *Reuse of heritage software, including MODAPS, SeaWiFS ODPS, OMIDAPS, and AIRS software* (<http://nppwww.gsfc.nasa.gov/>)
- Recipients (alphabetically): Gene Feldman, Steve Friedman, Evelyn Ho, Mary Hunter, Ed Masuoka, Curt Tilmes
- Peer Education Award Category: 1 recipient
  - **Robert E. Wolfe**, NASA GSFC
    - *General peer education, leading activities as Chair of the NASA ESDS Software Reuse Working Group* (<http://www.esdswg.com/softwarereuse/>)

We are also researching the standard processes for instituting new awards at Goddard and other NASA centers to determine if similar reuse awards can be created at those levels, possibly as new categories within existing awards.

Reuse Readiness Levels (RRLs): Following on work from previous years, the WG continued developing a set of RRLs designed to measure the reusability maturity of software assets. The topic area levels and overall RRLs were refined, and steps towards completing the work were identified, including the timeline for releasing a 1.0 publishable draft of the RRL document on the reuse portal web site near the beginning of 2010. We are currently developing a set of use cases for the RRLs, considering ways in which the RRLs can assist in software development, adoption, and sponsorship. These are currently in draft form, and we plan to complete them in the coming year, adding them to a future version of the RRL document.

We also recognize the need to test the RRLs by using them to assess existing reusable software assets. This will ensure that the levels are consistent and can be used by different assessors to achieve very similar results. We have identified four major steps in this process: (1) selecting reusable assets to assess, (2) performing the assessments, (3) analyzing the results of the assessments, and (4) revising the RRLs as needed. We plan to select a variety of assets (not just software code) from a number of applications (e.g., science data processing, data archive and distribution, data analysis) and assess them based on the use cases.

All of this work will be collected in a post 1.0 version of the RRL document that will be delivered to Headquarters as a recommendation for measuring the reuse maturity of reusable software assets. We are also planning to work with the IPP Office to examine the possibility of adding a place to report a software's or technology's RRL on new technology reports.

Decadal Survey Missions: During the 2009 ESDSWG Meeting, we continued our discussions regarding upcoming missions identified in the Earth Science and Applications from Space decadal survey report. From presentations made during the meeting by mission representatives, we recognize that the missions are reusing existing assets in order to achieve benefits provided by reuse (e.g., saving cost or development time). In considering how to assist the decadal survey and similar future missions in their reuse efforts, we identified the following possible areas for future WG activities: consider having a liaison between the WGs and the missions; work with the missions to identify who is responsible for informing reuse and the implementation of open source products; consider the possibility of enabling future mission contracts to cover software

specification and issues (e.g., licensing and release/distribution) to facilitate reuse; work towards making RRLs a powerful tool that can be used at mission reviews in the same way the well-established Technology Readiness Levels are currently used. Also, we have discussed the possibility of holding a workshop with representatives from the decadal survey missions to discuss their reuse needs, and to find out how our WG can better enable their reuse efforts. We plan to work with the other working groups on this subject, to host a joint ESDSWG / Decadal Survey Missions workshop to better enable collaboration between our projects. We plan to address these relevant issues as we are able to do so.

#### Publications and Presentations:

- Marshall, J.J. and the NASA ESDS Software Reuse Working Group, “Policies for a Proposed Reuse Enablement System (RES)”, presentation at the Winter 2009 ESIP Federation Meeting (January 2009, Washington, DC)
- Marshall, J.J., Downs, R.R., Gilliam, L.J., Wolfe, R.E., “Progress in the Development of a Prototype Reuse Enablement System”, poster presented at the NASA Goddard Space Flight Center Science and Exploration Directorate Science Poster Session (January 2009, Greenbelt, MD)
- Marshall, J.J., Downs, R.R., Samadi, S., “Relevance of Reuse in Building Advanced Data Processing Systems”, presentation at the 2009 Earth and Space Science Informatics Workshop (August 2009, Baltimore, MD)
- Marshall, J.J., Downs, R.R., Samadi, S. (2009), “Relevance of Software Reuse in Building Advanced Scientific Data Processing Systems”, submitted to special issue of Springer’s Earth Science Informatics journal
- Marshall, J.J., Downs, R.R., Samadi, S. (2009), “Building the Next Generation of Aerospace Data Processing Systems by Reusing Existing Software Components”, in *Aerospace Technologies Advancements*, Aleksandar Lazinica (Ed.), IN-TECH, in press
- Samadi, S., Marshall, J.J., Downs, R.R., “Building the Next Generation of Science Data Systems Using Service-Oriented Software Reuse”, poster presented at the 8<sup>th</sup> ESDS WG Meeting (October 2009, Wilmington, DE)
- Gerard, R., Marshall, J.J. (2009), Reuse Tradeoffs: A Case Study of Software Reuse within the NPP Mission, *Eos Trans. AGU 90(52)*, Fall Meet. Suppl., Abstract IN11C-1059. Poster presented at the 2009 AGU Fall Meeting (December 2009, San Francisco, CA)
- Devarakonda, R., Palanisamy, G., Green, J., Wilson, B.E. (2009), Mercury: Reusable software application for Metadata Management, Data Discovery and Access, *Eos Trans. AGU 90(52)*, Fall Meet. Suppl., Abstract IN11C-1060. Poster presented at the 2009 AGU Fall Meeting (December 2009, San Francisco, CA)
- Marshall, J.J., Downs, R.R., Gerard, R.S. (2009), Measuring Software Reusability for Scientific Data Systems, *Eos Trans. AGU 90(52)*, Fall Meet. Suppl., Abstract IN11C-1061. Poster presented at the 2009 AGU Fall Meeting (December 2009, San Francisco, CA)

## 2010 Planned Activities

### Major Tasks:

- Decadal survey missions
  - Plan for a workshop with missions to discuss reuse
  - Identify tangible benefits in missions (e.g., ICESat 2's reuse of ICESat, metrics, cost savings)
- Best practices and guidelines
  - Continue RRL work, including putting all items in one document and performing assessments of existing assets
  - Map ICESat metrics, etc. to RRLs
  - Continue developing a recommendation for packaging reusable assets
- Reuse Enablement System (RES)
  - Develop a roadmap for moving forward with proposed system
  - Identify gaps to following roadmap
- General
  - Strengthen the case for reuse to demonstrate achievement of reuse benefits
  - Work to get reuse product(s) into projects, e.g., RRLs into new technology reports (NTRs), liaisons between WG and missions
  - Review original WG Charter and revise if necessary (e.g., to cover WG's role in decadal survey and other future missions)

### Details on Tasks

- Reuse Enablement System: Develop an implementation plan for deployment, continue developing and testing prototype, deploy the prototype for internal NASA use, develop and vet RES policies (internal and external). Publish RES Policies 1.0 draft document and RES Test Plan 1.0 draft document for delivery in early 2010.
- Reuse Portal: Provide more content and keep up-to-date, promote portal to community, add RES roadmap (and schedule for RES deployment eventually).
- Provide Incentives for Reuse: Continue with WG peer award, continue to work to develop a NASA reuse award process, work on recommendation/justification for NASA Headquarters to develop a funding opportunity to make assets/components reusable within the Earth science community.
- Metrics/Measurement: Continue to generate/analyze statistics for portal Web site, assess efforts required to package assets for reuse, quantify the benefits of open source release of assets, and examine technology transfer process for small vs. large software components, consider using prototype RES to collect metrics, develop impact metrics from peer-award recipients, summarize the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) reuse study for portal Web site, coordinate metrics effort with Metrics WG as appropriate.
- Promote Reuse: Continue publications in journals and presentations at conferences, prototype a process for facilitating reuse through mentoring, continue developing RRLs (work with Standards WG and/or Technology Infusion WG as appropriate) and publish RRL 1.0 draft document for delivery in early 2010.

- Policy: Continue working with IPP Office to facilitate software release process, work to understand and change the process (lowering barriers for certain types of software).
- Data Life Cycle: work with data life cycle sub-group in the Technology Infusion WG to help with persistent (re)use areas
- Decadal Survey Missions: tie reuse efforts to decadal survey missions, prepare for reuse as a key part of (and asset for) new missions

The goal of all activities for 2010 is to deliver recommendations to NASA Headquarters for encouraging and enabling reuse, in part through the use of the products developed. We also plan to publish recommendation documents in the areas of software reuse on our portal web site and in suitable, relevant journals, books, etc. as appropriate.

WG Partnerships: Plan for a joint workshop with the decadal survey missions, focus on areas of cooperation and collaboration with other WGs (including Technology Infusion and Standards).

Outreach and Education Strategy: The WG Chair, Chris Mattmann, teaches a graduate course in software architecture at the University of Southern California (USC). Information from the Reuse WG will be disseminated in his course, which is taught regularly each Spring semester at USC. The WG also organized a poster session for the AGU 2009 Fall Meeting in San Francisco, which was convened by the former WG Chair, Robert Wolfe, and the WG Co-Chair, Robert Downs. Further, we plan to submit articles to Earth science journals, magazines, and bulletins, post Reuse WG announcements on list servers and newsletters, establish community collaboration forums for sharing reuse experiences, and utilize the portal Web site to disseminate outreach and education resources on reuse.

Challenges: We recognize the need to reach out to other Earth science domains, including the modeling community in particular, and to maintain connections with the ESIP Federation.

**Table 1 – 2009 Contributing Working Group Members**

<b>Member Name</b>	<b>Affiliation</b>	<b>NASA-Funded Project</b>	<b>NASA-Funded Project PI</b>
Corey Bettenhausen	SSAI / NASA GSFC	MEaSUREs – Consistent Long-term Aerosol Data Records over Land and Ocean from SeaWiFS	Christina Hsu
Bruce Caron	New Media Studio	ACCESS – Data and Information Application Layer (DIAL): Enabling Rapid NASA Data-Rich User Software Application Development	Bruce Caron
Robert R. Downs	Columbia University Center for International Earth Science Information Network (CIESIN)	Socioeconomic Data and Applications Center (SEDAC)	Robert S. Chen
Ryan Gerard	INNOVIM / NASA GSFC	ESDS Software Reuse Working Group Support Team	Frank Lindsay
Larry Gilliam	INNOVIM / NASA GSFC	ESDS Software Reuse Working Group Support Team	Frank Lindsay
Tommy Jasmin	University of Wisconsin Space Science and Engineering Center	REASoN – Satellite Observations in Science Education (SOSE)	Steven Ackerman
Louis Kouvaris	SAIC / NASA GSFC	REASoN – A Cross-Calibrated Multi-Platform Ocean Surface Wind Velocity Product for Meteorological and Oceanographic Applications	Joseph Ardizzone
Michael Leyton	Rutgers University		
James J. Marshall	INNOVIM / NASA GSFC	ESDS Software Reuse Working Group Support Team	Frank Lindsay



<b>Member Name</b>	<b>Affiliation</b>	<b>NASA-Funded Project</b>	<b>NASA-Funded Project PI</b>
Chris A. Mattmann	NASA JPL	Virtual Oceanographic Data Center (ROSES ACCESS, PI: Raskin), Coastal Marine Discovery Service (ROSES ACCESS, PI: Armstrong), Facilitating Climate Modeling Research By Connecting NASA and the Earth System Grid (IPP Seed Fund, PI: Crichton), Orbiting Carbon Observatory (OCO), NPP Sounder PEATE, Soil Moisture Active Passive (SMAP) mission	Crichton, Raskin, Armstrong
Neal Most	INNOVIM / NASA GSFC	ESDS Software Reuse Working Group Support Team	Frank Lindsay
Shahin Samadi	INNOVIM / NASA GSFC	ESDS Software Reuse Working Group Support Team	Frank Lindsay
Mark Sherman	SGT Inc. / NASA GSFC	ACCESS – High Spatial and Temporal Resolution Continental Water Mass Anomaly Fields from GRACE: Improving Accessibility for Hydrological Research and Applications	David Rowlands
Bruce Vollmer	NASA GSFC		
Christine Whalen	INNOVIM / NASA GSFC	ESDS Software Reuse Working Group Support Team	Frank Lindsay
Bruce Wilson	Oak Ridge National Laboratory	ORNL NASA Distributed Active Archive Center	Bruce Wilson
Robert E. Wolfe	NASA GSFC	ACCESS – Improving Access to Land and Atmosphere Science Products from Earth Observing Satellites: Helping NACP Investigators Better Utilize MODIS Data Products	Jeffrey Morisette

**Table 2 – Additional 2009 Working Group Members**

<b>Member Name</b>	<b>Affiliation</b>	<b>NASA-Funded Project</b>	<b>NASA-Funded Project PI</b>
Nadine Alameh	MobiLaps / NASA GSFC	Geosciences Interoperability Office	
Stephen Berrick	NASA GSFC	Goddard Earth Sciences (GES) Data and Information Services Center (DISC)	
Angelo Bertolli	Innovim / NASA GSFC	ESDS Software Reuse Working Group Support Team	
Bradford Castalia	University of Arizona	High Resolution Imaging Science Experiment (HiRISE)	Alfred McEwen
Saurabh Channan	University of Maryland	MEaSUREs – Global Forest Cover Change (GFCC) Project	John Townshend
Kamel Didan	University of Arizona	MEaSUREs – Vegetation Phenology and Vegetation Index Products from Multiple Long Term Satellite Data Records	Kamel Didan
Yonsook Enloe	SGT Inc. / NASA GSFC	ESDS Standards Process Group	
Stefan Falke	Washington University in St. Louis	REASoN – Services for Helping the Air-quality community use ESE Data (SHAirED)	Stefan Falke and Rudolf Husar
Albert Fleig	PITA / NASA GSFC	ACCESS – Atmospheric Composition Processing System (ACPS)	Curt Tilmes
Mike Folk	National Center for Supercomputing Applications (NCSA)	HDF Support for EOSDIS	
Bill Frakes	Virginia Tech		
Emily Greene	Raytheon / NASA GSFC	Microwave Limb Sounder	
Thomas Huang	NASA JPL	Physical Oceanography Distributed Active Archive Center (NASA PO.DAAC)	Bingham
Mary Hunter	Innovim / NASA GSFC	ESDS Software Reuse Working Group Support Team	
Gary Jackson	University of Maryland	Global Land Cover Facility (GLCF)	John Townshend
Virginia Kalb	NASA GSFC		
Marilyn Kaminski	National Snow and Ice Data Center	Distributed Active Archive Center	

<b>Member Name</b>	<b>Affiliation</b>	<b>NASA-Funded Project</b>	<b>NASA-Funded Project PI</b>
Kwo-Sen Kuo	UMBC / NASA GSFC		
David McComas	NASA GSFC	Flight Software Systems (GSFC Code 582)	
Stephen Olding	Everware-CBDI / NASA JPL	ESDS Technology Infusion Working Group	
Margaret Pippin	NASA Langley Research Center		
Ross Swick	National Snow and Ice Data Center	Distributed Active Archive Center	
Bill Teng	SSAI / NASA GSFC	REASoN – Integrating NASA ESE Data into Global Agricultural Decision Support Systems	Steven Kempler
Curt Tilmes	NASA GSFC	ACCESS – Atmospheric Composition Processing System (ACPS)	Curt Tilmes
Petr Votava	California State University Monterey Bay / NASA Ames		
Frederick Watson	California State University Monterey Bay	REASoN – Systems Integration & Visualization of Yellowstone (SIVY)	Frederick Watson
Jonathan Wilmot	NASA GSFC	Flight Software Systems (GSFC Code 582)	